Open Detonation vs. Blast Chamber

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Objective

Address stakeholder concerns about open detonations vs. detonation chambers

- **Public Concerns and Perceptions**
- **Chamber vs. Open Detonation**
- **Worker Safety**
- **Public Health**

Public Concerns

- **Cease Fire Campaign**
  - **A national campaign to end open air burning, detonation, and incineration of hazardous waste munitions**
    - **"…safer alternatives to open air burning and detonation…"**
    - **"…prevent the release of toxic emissions and pollutants…"**
    - **"…advance the principles of environmental justice…"**

- **Global Green USA**
  - **Comments on Vieques**
    - **"…it essential that the safest and most sustainable remediation practices are followed."**
    - **"…most old and abandoned ordnance can be safely destroyed by excavation, defused if necessary , removed, and eliminated in a variety of ways including closed detonation…"**

Environmental Justice

- **Media and political inquiries on Vieques**
  - **"Why are enclosed detonation chambers not being used for any ordnance that can be safely moved to these chambers?"**
    - **Point to chambers being used in Pueblo CO, Blue Grass KY, Massachusetts Military Reservation, China, Belgium, and Germany (mostly for chemical weapons)**
  - **"Could you explain how a controlled detonation would not lead to any quantity of explosive material in the air?"**
- **Media coverage of Camp Minden, LA**
  - **Plan for open burn of propellant in Louisiana vs. contained destruction of chemical agents in Pueblo CO**

Detonation Chamber

- **Closed Detonation Chamber (CDC) Types**
  - May be transportable or built in place
  - Various sizes, but all are large, heavy, and difficult to move
- **What detonation chambers do**
  - Contain or treat (at least partially)
    - Metal fragments
    - Shock wave (for high explosives)
    - Chemicals (for chemical weapons)
    - Gases produced
    - Noise
  - Produce some waste that must ultimately be addressed

Chamber vs. Open Detonation

- **With detonation chamber, munitions items must be handled and moved repeatedly**
  - **Find munitions item**
  - **Pick it up and move to a truck**
  - **Load onto truck and secure it**
  - **Transport to storage**
  - **Unload**
  - **Move into storage**
  - **Take out of storage**
  - **Prepare for demolition**
  - **Place in chamber**

- **Compared to open detonation**
  - **Blow in Place – item is never touched or moved**
  - **Consolidated detonation – items are picked up, carried short distance, and put down**

Detonation Chamber Applications

- **May be appropriate or needed in some cases:**
  - People nearby (too close for open detonation)
  - Chemical weapons
  - DMM (much safer to handle than UXO)
  - Munitions are small enough to go in chamber
    - Net Explosive Weight and overall dimensions
  - Can be moved and stored
  - Chamber can be moved to the site

- **A very narrow window of applicability**
  - Chemical weapons under Army
  - Many MRP sites are remote or access controlled
  - Many sites involve UXO
  - In the past, vendors have oversold detonation chambers

Chamber Model	Munition Capability
T-10	105 mm or equivalent
T-25	5-inch (127mm) or equivalent multiple smaller munitions
T-30/60	155mm or equivalent multiple smaller munitions

Munitions Safety

- The cardinal rule is “expose the fewest number of people to the least amount of explosives for the shortest period of time.”
  - “You can never be too safe when handling explosives.”
- Historical accidents
  - Many involve EOD and site workers
- Camp Pendleton, 2013
  - Explosion killed four Explosive Ordnance Disposal (EOD) Marines
  - A grenade was "dropped, kicked or bumped," and set off an explosion among other items that had been gathered for demolition.

The vast majority of munitions accidents occur after an item has been picked up (ACOE, 2011) and (EPA 2001).

Munitions Safety Guidance

- **EPA Guidelines (OSWER Directive 9200.1-101)**
  - **"EPA expects great weight and deference to be given to the decisions of explosives or munitions emergency response specialists and to UXO qualified personnel at the field level…"**
- **DOD Explosives Safety Guidance (DOD 6055.9M)**
  - **V7.E3.3.3. "There are no safe procedures for moving, rendering safe, or destroying UXO, but merely procedures considered less dangerous. Destruction-in-place (also referred to as blow-in-place (BIP)) is the least dangerous; therefore, it is the preferred method of UXO destruction."**
- **Site workers have the vast majority of encounters with munitions**

Recommend we avoid saying "safe to move" especially when talking about UXO

Chamber Disadvantages

- **Some** munitions items are
  - Too dangerous to move or store
  - Too big (depends on size of the chamber)
    - Net Explosive Weight (NEW) too high (would result in BTSOOTC)
    - Munitions item won't fit inside

- For **all** munitions items and for all types of chambers
  - Chamber requires repeated handling of munitions
    - Puts site workers at risk (violates cardinal rule and DOD 6055.9M)
  - Much slower process than open detonation
    - People are exposed to munitions for a longer period of time (violates cardinal rule, and land reuse is delayed
  - Detonation chambers not readily available
    - CH2M no longer provides the service; chamber back with the original developer, Demil International
  - Detonation chamber difficult to locate to remote sites
  - High cost

Why Use Open Detonation?

- **Safety**
  - **Some munitions cannot be moved at all**
    - **Ex. submunitions**
  - **For munitions that can be moved, open detonation is still the safest method because it minimizes handling**
    - **The safest approach always involves the least amount of handling.**
    - **No UXO items are completely safe to move.**
    - **To protect the safety of site workers, it is standard practice in the munitions cleanup industry to avoid the movement and handling of unexploded munitions as much as possible.**
  - **The use of a detonation chamber requires workers to handle each item repeatedly**
    - **On Vieques, the munitions would need to be picked up, loaded on trucks, transported over rough roads, loaded into storage, taken out of storage, and finally placed in the detonation chamber.**
    - **Repeatedly handling of thousands of MEC creates unacceptable risk**

Why Use Open Detonation?

- **Human Health and Environment**
  - **Open detonation can be performed in a way that is protective of human health and the environment (EPA, 1998 and SEESAC, 2004).**
  - **On Vieques, the Navy has performed extensive air monitoring. Since 2005 over 1,600 air samples have been collected during more than 177 detonation events.**
  - **Air was monitored for PM10, PM2.5, explosive compounds, and the metals mercury, lead, arsenic, cadmium, iron, nickel, and copper, chromium, tin, and phosphorus.**
    - **No explosive compounds have ever been detected.**
    - **Iron, nickel, and copper have been detected, but all concentrations were at least 99% below health based standards.**
    - **PM10 and PM2.5 results have shown no violations of the National Ambient Air Quality Standards (NAAQS).**

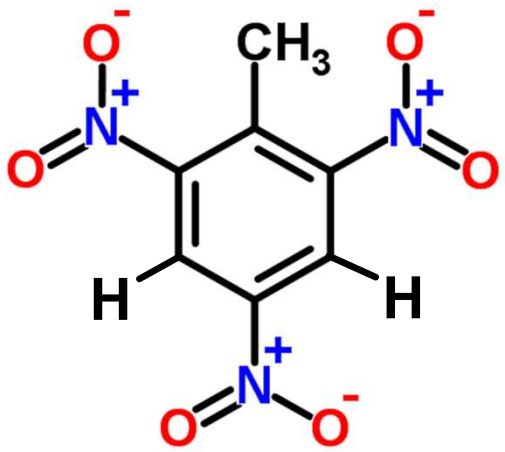
Stakeholders question these results, but they are expected due to the nature of the explosion process.

Explosion Process

- **Rapid chemical reaction that produces extreme heat, pressure, and gas**
  - **Chemical energy converted to kinetic energy and heat**
    - **Fragments propelled at 2,000 to 9,000 mph**
    - **Thousands of degrees (~2,000 to 5,000 °C)**
    - **Many thousands of atmospheres (~30,000 to 400,000 atm)**
  - **One gram of explosive produces about 1 liter of gas (stp)**
- **Detonation: from Latin *detonare*, to expend thunder**
  - **Produces a loud, sharp bang**

Explosive Chemicals *(High Explosives)*

- **Oxygen bonded to nitrogen; carbon and hydrogen are fuels**
  - **TNT (Trinitrotoluene) has the atoms:**
    - **Carbon, C and Hydrogen, H**
    - **Nitrogen, N**
    - **Oxygen, O**
  - **Energy is stored in the chemical bonds**

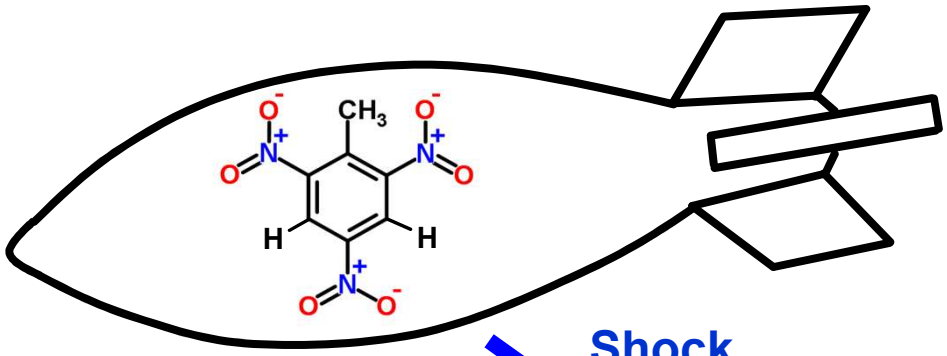


- **Metals:**
  - **Aluminum increases explosive power**
  - **Lead in primary explosives**
  - **Inorganics to produce light (flares)**
    - **Magnesium, aluminum → white**
    - **Strontium → red**
    - **Barium → green, Copper → blue**

$C_7 H_5 N_3 O_6$

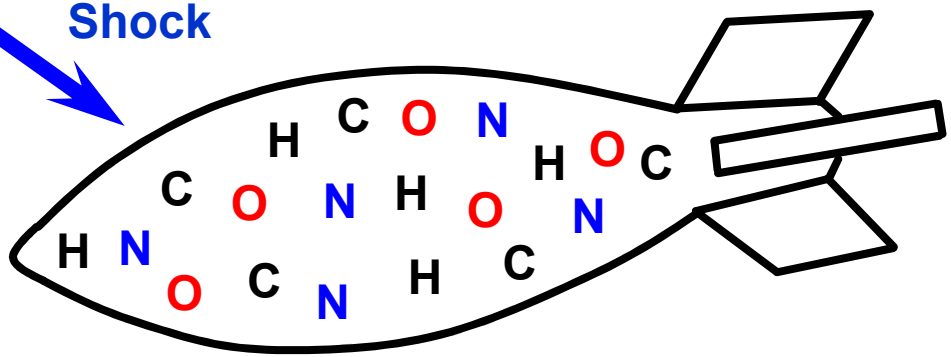
People may not understand the difference between Chemical Munitions and the chemicals in High Explosive (HE) Munitions

Detonation

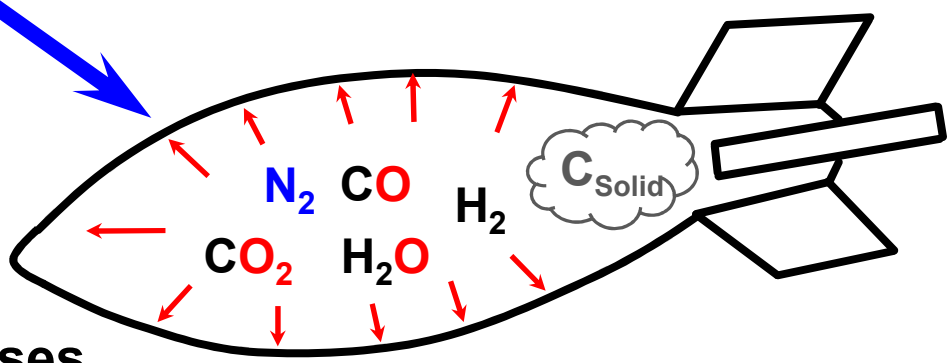


Solid TNT

Shock



Atoms



Gases

PV = nRT

These reactions are exothermic and produce extreme heat.

Makeup of Munitions

- **MIDAS Database**
  - **Munitions Items Disposition Action System (MIDAS)**
  - **Gives the weight of each chemical compound in munitions item**
    - **Some items have dozens of variations**
- **Explosives**
  - **The usual suspects – RDX, TNT, HMX, Nitrocellulose, etc.**
  - **Aluminum powder, lead azide, etc.**
- **Metals**
  - **High in iron (highest), aluminum, and copper**
  - **Medium in zinc, chromium, lead, manganese, nickel**
  - **Low in vanadium, cadmium, titanium, etc.**
  - **Haven't seen arsenic in the database so far**
- **Other**
  - **Asphalt, wax, alcohols, solvents, BTEX, pigments, etc.**

Open Detonation

- EPA has published emissions factors, based on DOD data
  - Hg, As, Ni, and Be not detected above background levels
  - Unconfined detonations are “cleaner” than confined
- Explosive chemicals
  - For high order, close to 100% of the explosive chemicals are converted to gases that exist in the atmosphere
    - Mostly CO_2, H_2O, N_2, and H_2
    - Generally less than 2% CO and 3% NOx
    - Soot (C) released if explosive is oxygen deficient (TNT for example)
- Metals
  - Fragments fall to the ground
  - Small particles and compounds released to the air
- Other
  - Particulate matter (soil and pulverized rock)
  - VOCs and a few SVOCs (all are commonly found in ambient air)

Other Considerations

- **Sustainability**
  - **Overall impact to the environment of shipping and setting up the detonation chamber**
- **Open Detonation vs. Open Burning**
  - **Open Burning often involves millions of pounds of excess propellant or other explosives.**
  - **Open Detonation and Open Burning are not the same process and do not result in the same air quality issues.**
- **Explosive chemicals vs. chemical weapons**
  - **Be sure stakeholders understand the difference**

Summary

- **Detonation Chamber**
  - Requires workers to handle munitions repeatedly
  - Takes longer than open detonation
    - More time for exposure to munitions hazard
    - Delays land re-use
- **Open Detonation**
  - Requires little or no handling of munitions
    - No munitions are completely safe to move
  - Open detonation can be performed in a way that is protective of human health and the environment
    - Detonation releases normal atmospheric gases
    - Regulators are likely to require verification samples

Knowledge Check

- **Write a 2,000 word essay that compares and contrasts open detonation and controlled detonation chamber**
- **True or False – detonation chambers require little movement or handling of munitions.**

  False
- **True or False – some UXO items are safe to move**

  False
- **True or False – detonations release mostly CO2, H2O, N2, and H2 gases**

  True

Contacts and Questions

Points of Contact

NAVFAC Atlantic:

Stacin Martin

Tim Wenk

Mike Green

Daniel Hood

Kevin Cloe

Dan Waddill

- **Email available on the global address list (GAL)**

Questions ?

Supplemental Information

List Helpful Resources

- *A Study of MEC-Related Civilian Incidents Associated with FUD Sites* (ACOE, 2011), QuantiTech Inc.
- *UXO Incident Report* (EPA 2001), DPRA Inc., data from DDESB and ATF.
- Emission Factors for the Disposal of Energetic Materials by Open Burning and Open Detonation (OB/OD), US Environmental Protection Agency, EPA/600/R-98/103, 1998, http://www.epa.gov/sites/production/files/2015-02/documents/1998_emission_factors_for_the_disposal_of_energetic_materials_by_ob-od.pdf.
- SALW Ammunition Destruction – Environmental Releases from Open Burning (OB) and Open Detonation (OD) Events, South Eastern Europe Clearinghouse for the Control of Small Arms and Light Weapons (SEESAC), 2004.